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Prime Item Development Specification for the Payload Rack Checkout Unit (PRCU)

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Huntsville, Alabama

by

Boeing Defense & Space Group
Missiles & Space Division
(a division of The Boeing Company)
Huntsville, Alabama

Authenticated by ____________________ **Approved by** __________________________
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INTERNATIONAL SPACE STATION PROGRAM
SCIENCE AND UTILIZATION SEGMENT

PRIME ITEM DEVELOPMENT SPECIFICATION
FOR THE PAYLOAD RACK CHECKOUT UNIT
(PRCU)

18 NOVEMBER 1996

CONCURRENCE

PREPARED BY:	Julie T. Graham PRINT NAME	2-8K37 ORGN
	Julie T. Graham SIGNATURE	11/18/96 DATE
CHECKED BY:	Chris Barker PRINT NAME	2-8K37 ORGN
	Chris Barker SIGNATURE	11/18/96 DATE
SUPERVISED BY: (BOEING)	Forrest Callicutt PRINT NAME	2-8K37 ORGN
	Forrest Callicutt SIGNATURE	11/18/96 DATE
QA:	Dean Goglin PRINT NAME	2-4850 ORGN
	Dean Goglin SIGNATURE	11/20/96 DATE
DQA:	Glen Cox PRINT NAME	2-8C26 ORGN
	Glen Cox SIGNATURE	12/09/96 DATE
CM:	Bill McElrath PRINT NAME	2-8C26 ORGN
	Bill McElrath SIGNATURE	12/05/96 DATE

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1. SCOPE

1.1 Introduction. This document is identified as the Prime Item Development Specification (PIDS) for the Payload Rack Checkout Unit (PRCU), S683-27515.

1.2 System overview. The PRCU is a transportable integration and test environment that provides a high fidelity emulation of the data and resource interfaces between the International Standard Payload Rack (ISPR) and the International Space Station (ISS). The PRCU provides data and resource interface testing for one payload which may be physically contained in up to three ISPR locations. The requirements in this specification define physical and data resources provided to the payload rack. For our purposes, a payload rack is defined as one or more (maximum of three) ISPR locations that are controlled by the Payload Multiplexer/Demultiplexer (MDM) as a single entity. The PRCU uses the term emulation because actual hardware and ISS Functional Equivalent Units (FEUs) are utilized to provide the physical resources (i.e. power, thermal cooling, gas, and/or vacuum) and the data resources to the payload rack under test. The PRCU provides test verification of a payload's interface to the Command & Data Handling (C&DH) system, the Internal Audio/Video (IAV) portion of the Communication & Tracking (C&T) system, the Electrical Power System (EPS), the gaseous interfaces (Nitrogen, Argon, Carbon Dioxide, and/or Helium), the Internal Thermal Control System (ITCS), and the Vacuum System (VS). The PRCU allows the payload developer to complete development prior to payload shipment to Kennedy Space Center (KSC).

1.3 Document overview. The PIDS for the PRCU defines the requirements that must be satisfied in order to develop a PRCU that is capable of verifying the ISPR to ISS interfaces. Figure 1 illustrates the requirements flow between the PRCU PIDS and parent ISS documentation. The PRCU requirements defined in this specification will be verified during PRCU acceptance testing. Requirements in section 3.2.1 define the performance of the PRCU as a whole. Requirements in section 3.7 define the performance of each of the major components that comprise the PRCU.

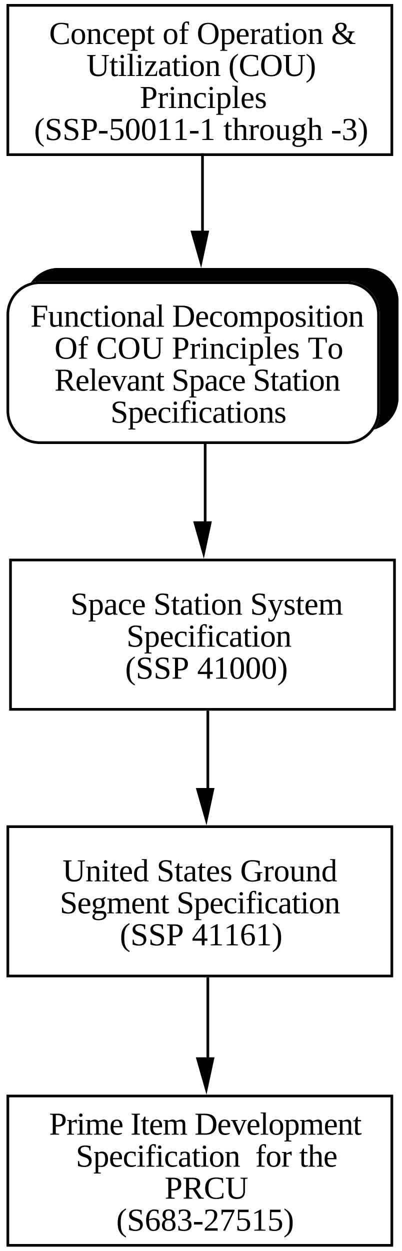

FIGURE 1 PRCU Specification Tree

2. APPLICABLE DOCUMENTS.

The following documents form a part of this specification to the extent specified herein. Documents referenced in the following specifications and standards are also a part of this specification and are applicable to the extent specified in the text to meet the requirements of this document.

2.1 Government documents. The following documents of the exact issue shown or if no issue is specified, the issue in effect at the date of contract agreement shall form a part of this document to the extent specified herein. In the event of conflict between the documents listed below and the contents of this document, the contents of this document shall govern.

SPECIFICATIONS

National Aeronautics and Space Administration (NASA)

SP-M-502 Rev B	Configuration Item Specification Payload Ethernet Hub/Gateway (PEHG)
NHB-5300.4(1B)	Quality Program Provisions for Aeronautical and Space System Contractors
NHB-2410.9	NASA Automated Information Security System Handbook
SSP 41000	Space Station System Specification
SSP 41161	United States Ground Segment Specification
SSP 41175-8	Software ICD, Part 1, Station Management & Control to ISS, Book 8, Payload Multiplexer/ Demultiplexer (MDM) Interface
SSP 50011-1	Concept of Operations (COU) Principles
SSP 50011-2	COU Mission Scenarios and Mission Profiles
SSP 50011-3	COU Processes
SSP 52051	User Electrical Power Specifications and Standards
SSP 30573, Rev A	Space Station Program Fluid Procurement and Use Control Specification
SSP 52000 Rev A, Draft	Pressurized Payloads Interface Definition Document

STANDARDS

Federal

29 CFR 1910	29 Code of Federal Regulations 1910 - Occupational Safety & Health Administration (OSHA) (Safety Standards)

Military

MIL-STD-130 Rev F	Identification Marking of U.S. Military Property
MIL-STD-1553B Rev B	Digital Time Division Command/Response Multiplex Data Base
MIL-STD-1472 D	Human Engineering Design Criteria for Military Rev Systems, Equipment, and Facilities

2.2 Non-Government documents. The following documents of the exact issue shown or if no issue is specified, the issue in effect at the date of contract agreement shall form a part of this document to the extent specified herein. In the event conflict between the documents listed below and the contents of this document, the contents of this document shall govern.

SPECIFICATIONS

STANDARDS

ANSI/IEEE 802.3	Carrier Sense Multiple Access/Collision Detection Local Area Network Specification, Type 10BASE-T
ASME/ANSI B31.1	Power Piping

OTHER PUBLICATIONS

NFPA-70	National Electric Code, 1990, National Fire Protection Association, Batterymarch Park, Quincy, MA

2.3 Reference Documents. The following documents were used for information in deriving, or supporting, systems requirements and associated documentation.

D683-21415-1	PSIV to Payload Data Library (PDL) ICD
D683-21439-1	PRCU Metrology Plan
D683-21441-1	PRCU User's Guide
D683-27522-1	PRCU Maintenance Plan
D683-41212-1	PSIV/F Development Plan

3 . REQUIREMENTS.

3.1 Prime item definition. The PRCU provides a transportable high fidelity emulation of the ISPR data and resource interfaces utilized by U.S. payloads, regardless of where that payload is manifested (i.e. U.S. Lab, Attached Pressurized Module (APM), Japanese Experiment Module (JEM), Centrifuge Accommodations Module (CAM), or attached to the truss). The PRCU will be used to support the test and verification of a payload's interface to the ISS systems. The PRCU is capable of supporting test and verification procedures for one payload occupying one to three ISPR locations.

The PRCU contains a Payload MDM FEU which utilizes flight software to allow high fidelity verification of the C&DH interface. The PRCU also includes a set of off line tools to assist the payload developer in the development of user screens, data tables, and other ISS program required software. The PRCU provides an interface to the User Operations Facility (UOF) to checkout the interactions between the payload and the ground systems.

The PRCU allows payload development and verification testing to be conducted at the developer's site. This enables the developer to exercise the full functionality of their payload prior to shipment to KSC and delivery to the ISS on orbit.

3.1.1 Prime item diagram. The PRCU prime item diagram is illustrated in Figure 2.

3.1.2 Interface definition. The external interface section defines the functional and physical interfaces between the PRCU and external entities. The internal interface section defines the interfaces between the major components that comprise the PRCU.

3.1.2.1 External interfaces. The PRCU has external interfaces to the ISPR, an attached payload, the Payload Software Integration & Verification Facility (PSIVF), the Payload Data Library (PDL), the ground (UOF and/or the Payload Data Services System (PDSS)), and the user facility. Figure 3 illustrates the external entities that interface with the PRCU.

3.1.2.1.1 PRCU to ISPR external interfaces. The PRCU will be capable of testing the data and resource interfaces that are available on the ISPR Common Module Utility Interface Panel (UIP) shown in Figure 4. In addition to these interfaces, the PRCU also accommodates interfaces for the Medium Rate Data Link (MRDL), a second cooling loop, and JEM unique gases of Argon, Carbon Dioxide, and Helium. The PRCU to ISPR external interfaces will meet the ISPR performance requirements for the U.S. Lab, the APM, the JEM, and the CAM as defined in SSP 52000, Pressurized Payloads Interface Definition Document (IDD). The PRCU will provide flight equivalent data and resource connectors that will be identical to the flight articles in terms of form, fit, clocking, rotation, and cleanliness. However, the PRCU is not responsible for verifying cable routing and/or cable length between the UIP and the payload. Figure 5 illustrates the PRCU to ISPR external interface diagram.

> The PRCU shall support the test and verification of one payload that may be mounted in up to three ISPR locations.

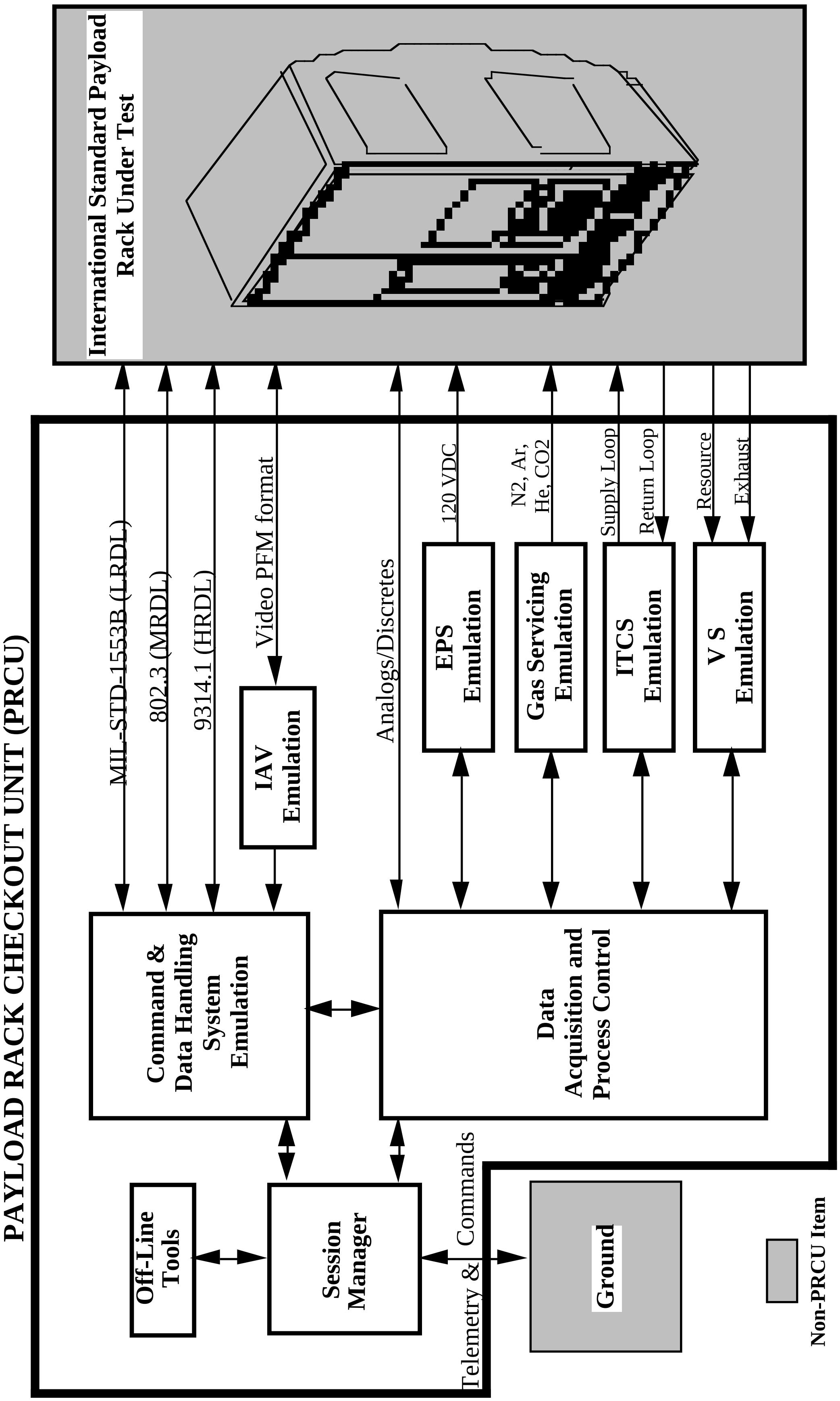

FIGURE 2 PRCU Prime Item Diagram

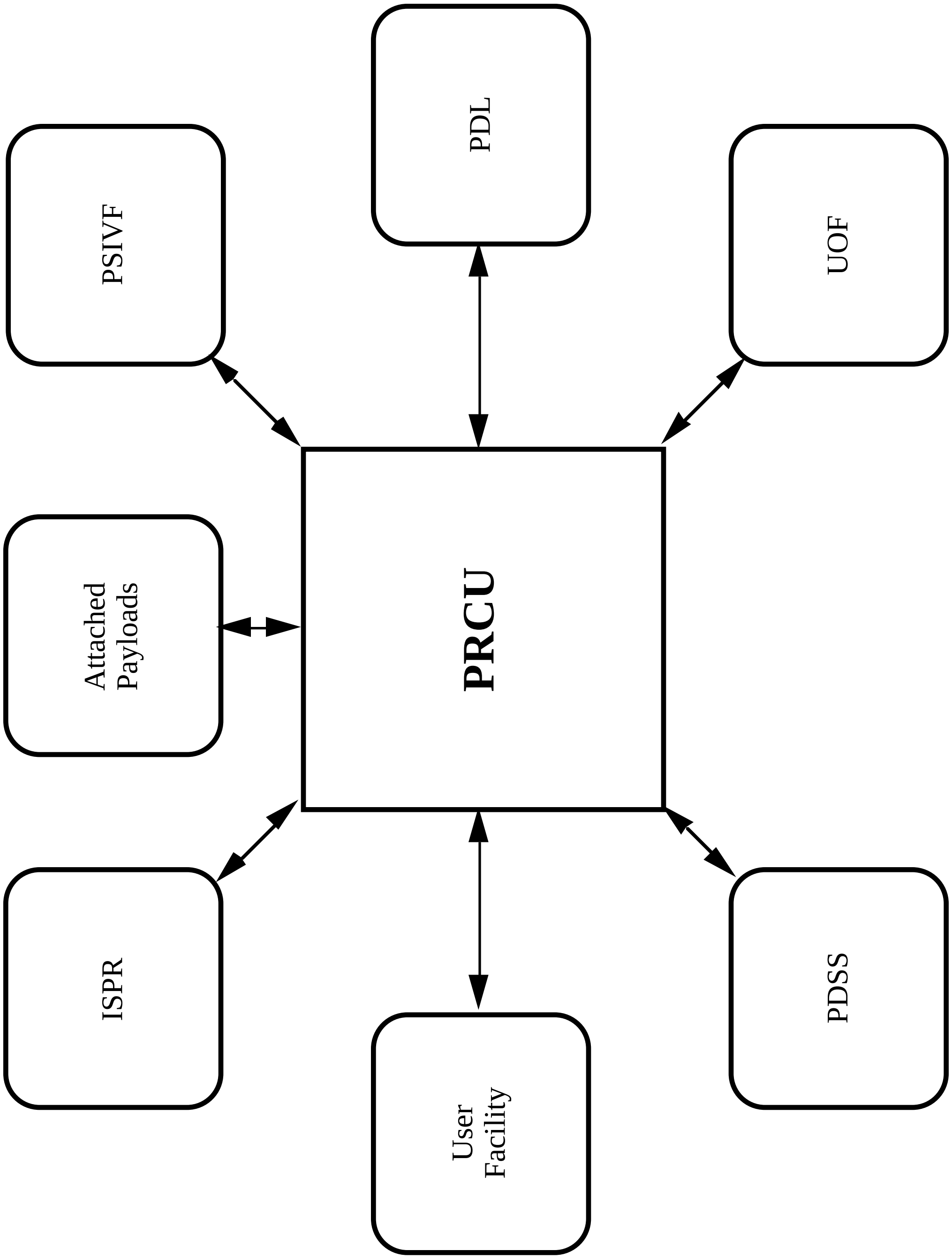

FIGURE 3 PRCU External Interface Diagram

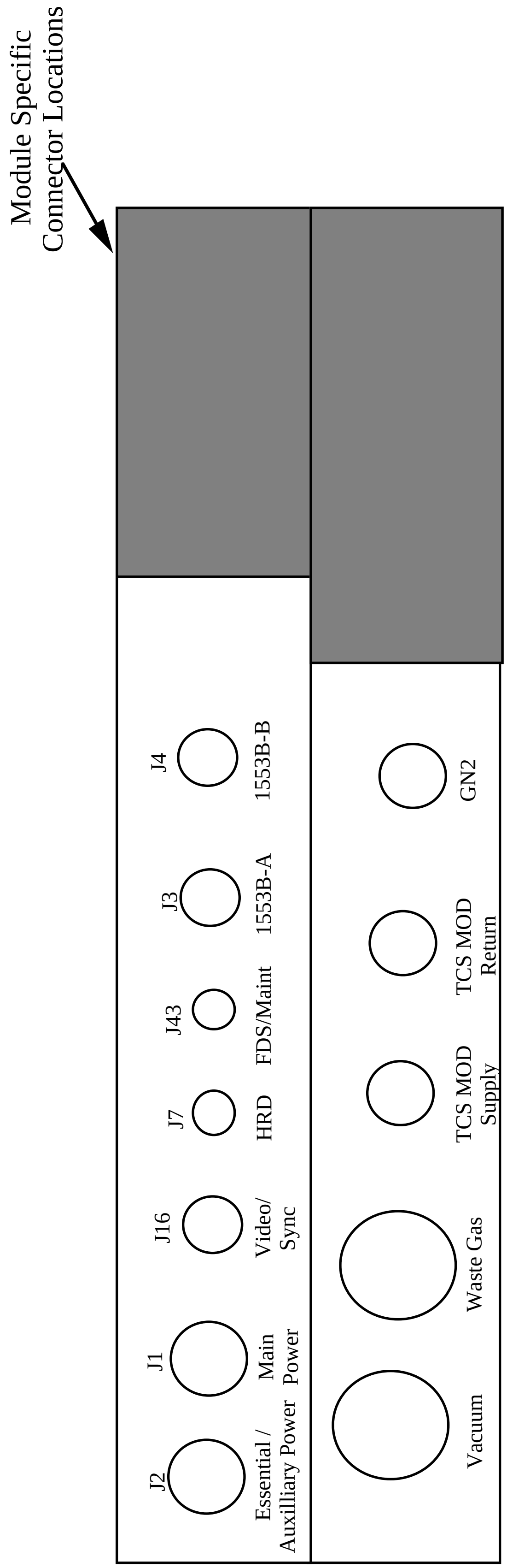

FIGURE 4 Common Module Utility Interface Panel

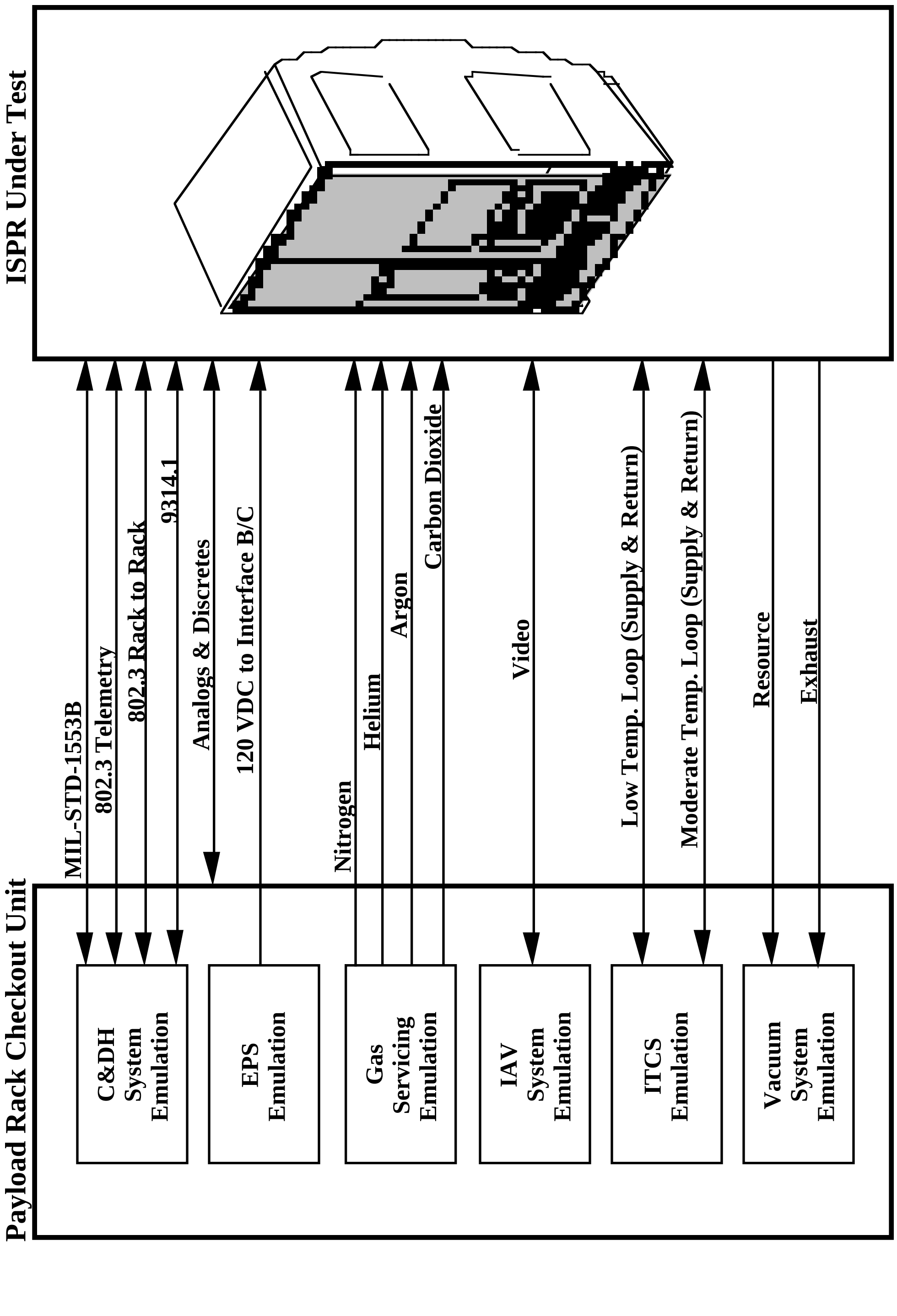

FIGURE 5 PRCU to ISPR External Interface Diagram

3.1.2.1.1.1 C&DH system emulation interfaces. The C&DH system emulation will test the payload to Payload MDM interfaces to ensure that messages are built in compliance with the MIL-STD-1553B protocol and meet the Consultative Committee for Space Data System (CCSDS) packet format.

The C&DH system emulation will check messages for proper CCSDS header format on payload data that requires ground processing by ISS provided systems. The C&DH system emulation will test the interfaces between the payload MDM and the payload rack.

The C&DH system emulation will check MRDL messages for proper compliance with the Ethernet protocol as defined by IEEE 802.3 data format standards and proper CCSDS packet format for payloads that utilize the ISS MRDL

The C&DH system emulation will check High Rate Data Link (HRDL) messages for proper compliance with the Space Station Program (SSP) To Be Determined (TBD) 1 for proper HRDL packet or Bitstream packet format for payloads that utilize the ISS HRDL.

a. The PRCU C&DH system emulation shall provide the capability to transmit MIL-STD-1553B ISS generated protocol messages to the payload.

b. The PRCU C&DH system emulation shall receive MIL-STD-1553B protocol messages from the payload.

c. The PRCU C&DH system emulation shall provide MIL-STD-1553B connections to accommodate user provided test equipment.

d. The PRCU C&DH system emulation shall provide the capability to transmit 802.3 Ethernet ISS generated protocol messages to the payload rack.

e. The PRCU C&DH system emulation shall receive 802.3 Ethernet protocol messages from the payload rack.

f. The PRCU C&DH system emulation shall provide 802.3 Ethernet connections to accommodate a user or program provided laptop.

g. The PRCU C&DH system emulation shall provide 802.3 Ethernet connections to accommodate user provided test equipment.

h. The PRCU C&DH system emulation shall provide the capability to transmit SSP TBD1 formatted HRDL ISS generated protocol messages to the payload rack.

i. The PRCU C&DH system emulation shall receive SSP TBD1 formatted HRDL protocol messages from the payload rack.

j. The PRCU C&DH system emulation shall interface with the payload rack via flight quality connectors or connector savers.

3.1.2.1.1.2 Electrical Power System emulation interfaces. The PRCU EPS emulation will provide station compatible power to the payload under test. The PRCU EPS emulation will enable the payload developer to show that the interface connectors, grounding, shielding, isolation, and termination characteristics of the payload meet the ISPR interface (Interface B and C) requirements for safety, quality, steady–state, abnormal, ripple, and transient voltage characteristics. Figure 6 illustrates the EPS interfaces that are defined as Interface B and C in SSP 52051, User Electrical Power Specification and Standards.

The PRCU EPS emulation will test the ISPR power characteristics to ensure that the ISS requirements for inrush current to the rack and reverse energy/current to the power source are not exceeded. The PRCU EPS emulation will also verify that the circuit protection devices and the conductor insulation resistance of the payload meet ISS requirements.

a. The PRCU EPS emulation shall provide electrical power compatible with the ISS EPS power characteristics provided at Interface B or Interface C of UIP at up to three ISPR locations.

b. The PRCU EPS emulation shall interface with the payload rack via flight quality connectors or connector savers.

c. The PRCU EPS emulation shall verify the 1.5 kW, 3 kW, or 6 kW power interface and the essential bus interface at the payload rack.

3.1.2.1.1.3 Gas servicing emulation interfaces. The PRCU gas servicing emulation will provide station compatible gases to the payload under test.

a. The PRCU gas servicing emulation shall be capable of providing gaseous nitrogen to the payload rack.

b. The PRCU gas servicing emulation shall be capable of providing gaseous argon to the payload rack.

c. The PRCU gas servicing emulation shall be capable of providing gaseous helium to the payload rack.

d. The PRCU gas servicing emulation shall be capable of providing gaseous carbon dioxide to the payload rack.

e. The PRCU gas servicing emulation shall provide gas service connections that are compatible with the ISS gas service connections available on the UIP.

f. The PRCU gas servicing emulation shall interface with the payload rack, via flight quality connectors or connector savers.

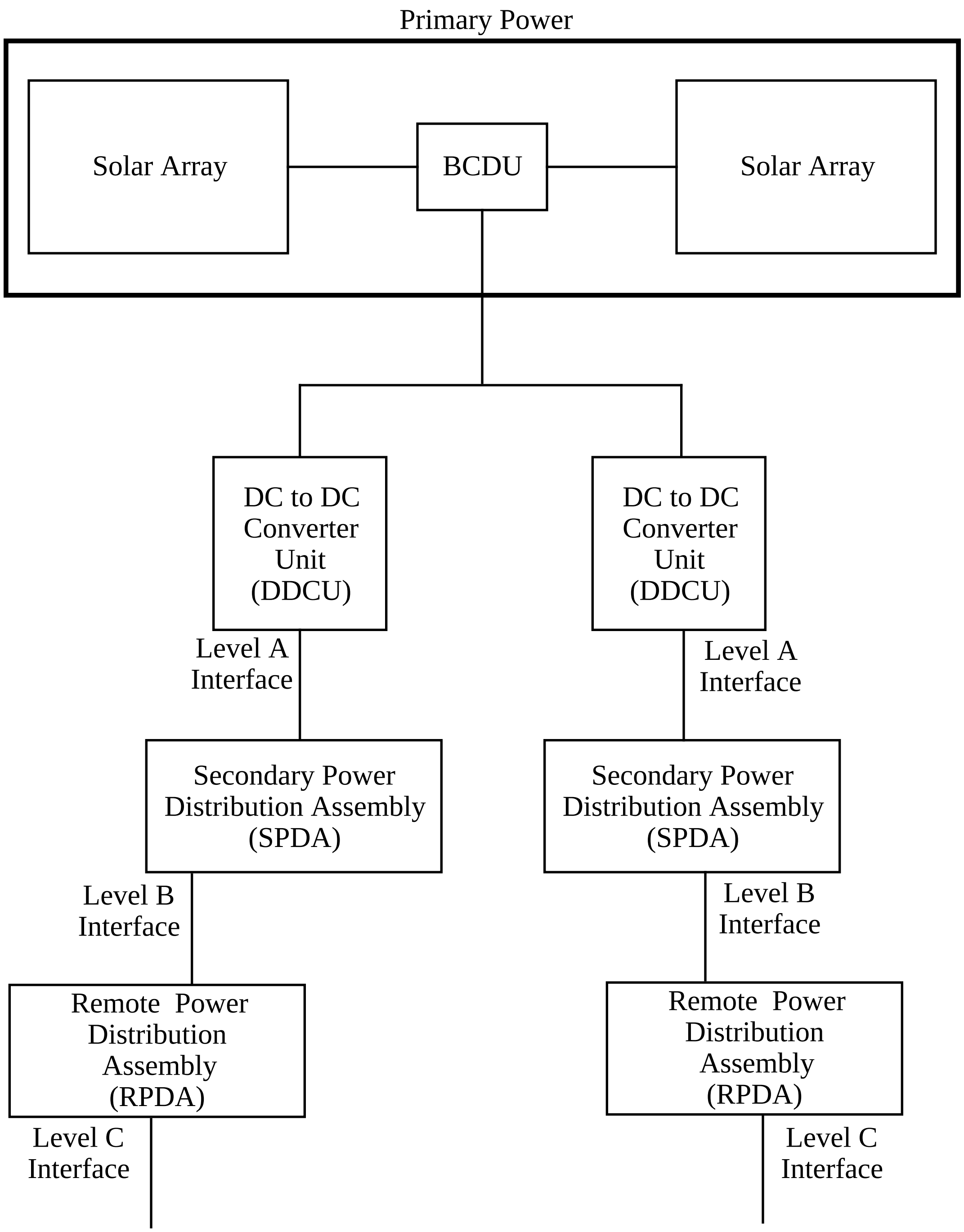

FIGURE 6 Definition of EPS Level B and Level C Interfaces

3.1.2.1.1.4 IAV system emulation interfaces. The PRCU IAV system emulation will support the test and verification of the payload's interface to the IAV portion of the ISS C&T system. An internal video conversion unit will translate fiber-optic Pulse Frequency Modulated (PFM) video/sync signals coming from the ISPR into baseband NTSC/170A video/sync signals. The PRCU IAV system emulation will provide a broadcast quality color monitor for viewing video output from the ISPR.

a. The PRCU IAV system emulation shall receive PFM Fiber Optic (FO) video signals from the payload rack.

b. The PRCU IAV system emulation shall provide PFM fiber optic video signals to the payload rack.

c. The PRCU IAV system emulation shall be capable of converting PFM signals to the National Television Systems Committee (NTSC) format.

d. The PRCU IAV system emulation shall be capable of receiving payload video & sync. signals in NTSC format.

e. The PRCU IAV system emulation shall be capable of converting payload video signals from NTSC format to PFM format.

f. The PRCU IAV system emulation shall interface with the payload rack via flight quality connectors or connector savers.

3.1.2.1.1.5 ITCS emulation interfaces. The PRCU ITCS emulation will provide station compatible moderate and low temperature cooling capabilities to the payload rack.

a. The PRCU ITCS emulation shall provide low and moderate temperature water cooling to the payload rack.

b. The PRCU ITCS emulation shall be capable of providing low and moderate temperature water cooling simultaneously and independently to the payload rack.

c. The PRCU ITCS emulation shall provide low and moderate temperature water cooling connections that are compatible with the ISS ITCS connections provided on the UIP.

d. The PRCU ITCS emulation shall interface with the payload rack via flight quality connectors or connector savers.

3.1.2.1.1.6 VS emulation interfaces. The PRCU VS emulation will emulate the ISS Vacuum Resource System (VRS) and Vacuum Exhaust System (VES) interfaces to the payload under test. Utilizing a non-polluting pumping unit, variable vacuum pressure settings may be applied via lines attached using ISS compatible connectors.

a. The PRCU VS emulation shall provide a vacuum resource to the payload rack.

b. The PRCU VS emulation shall accept waste gas from the payload rack.

c. The PRCU VS emulation shall provide resource and waste gas connections at the payload rack that are compatible with the ISS VS connections provided on the UIP.

d. The PRCU VS emulation shall interface with the payload rack via flight quality connectors or connector savers.

3.1.2.1.1.7 Data Acquisition & Process Controller (DAPC) interface.

The PRCU DAPC shall interface with the payload rack for the transmittal and receipt of analog and discrete signals for the maintenance switch and the Fire Detection & Suppression (FDS) system.

3.1.2.1.2 PRCU to Attached Payload external interface. The PRCU to Attached Payload interface defines the data available to test and verify the ISS interfaces to attached payloads mounted on the truss.

a. The PRCU shall provide the data and resource interfaces defined in section 3.1.2.1.1 to support the test and verification of attached payloads.

b. The PRCU shall provide TBD2 data and resource connectors to support the test and verification of attached payloads.

3.1.2.1.3 PRCU to PSIVF external interface. The PRCU to PSIVF interface defines the data that will be exchanged between the PRCU and the PSIVF to support payload interface test and verification. This is an off line interface that supports file transfer, via the Internet, between the two entities. Figure 7 illustrates the PRCU to PSIVF external interface.

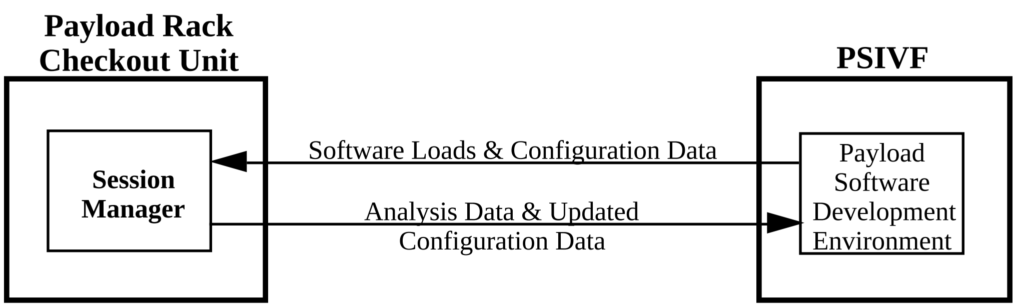

FIGURE 7 PRCU to PSIVF External Interface Diagram

a. The PRCU shall interface with the PSIVF Payload Software Development Environment (PSDE) for the electronic receipt of software loads and configuration data to support payload interface test and verification at the payload developer's site.

b. The PRCU shall interface with the PSIVF PSDE to electronically transfer updated configuration data and analysis data to support payload software integration and verification.

3.1.2.1.4 PRCU to PDL external interface. The PRCU to PDL interface defines the data that will be transferred to support interface test and verification activities. This is an off line interface that supports file transfer, via the Internet, between the two entities. Figure 8 illustrates the PRCU to PDL external interface.

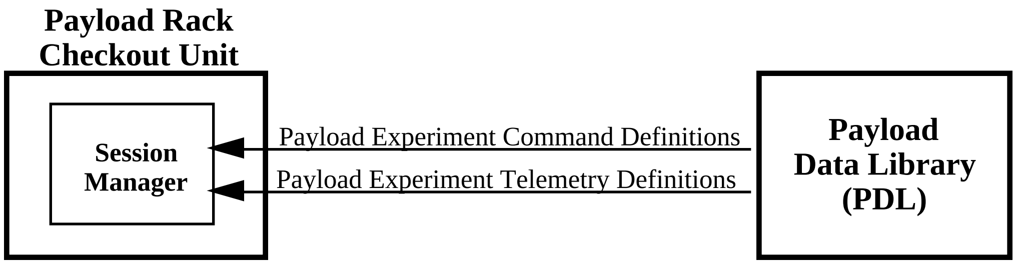

FIGURE 8 PRCU to PDL External Interface Diagram

a. The PRCU session manager shall interface with the PDL for the electronic receipt of payload experiment command definitions as defined in the PSIVF to PDL ICD (D683-21415-1).

b. The PRCU session manager shall interface with the PDL for the electronic receipt of payload experiment telemetry definitions as defined in the PSIVF to PDL ICD(D683-21415-1).

3.1.2.1.5 <u>PRCU to ground facilities external interface.</u> The PRCU to ground facilities interface defines the data that will be exchanged between the PRCU and various ground facilities such as a UOF and/or the PDSS. Figure 9 illustrates the PRCU to Ground external interface diagram.

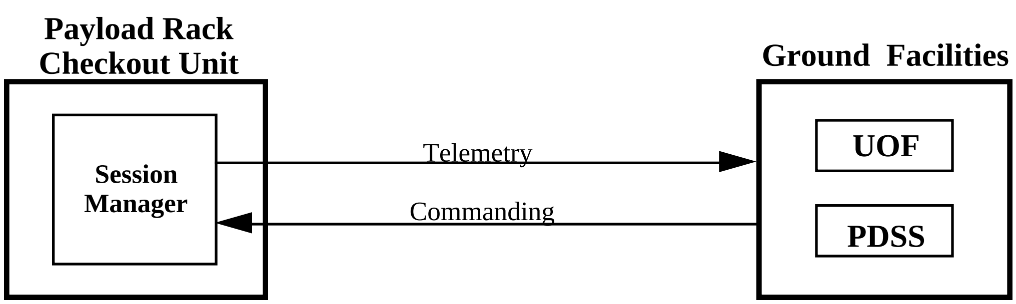

FIGURE 9 PRCU to Ground External Interface Diagram

a. The PRCU session manager shall provide telemetry data to a UOF in a format that is compatible with TBD3 specification.

b. The PRCU session manager shall receive payload commanding data from the UOF in a format that is compatible with TBD3 specification.

c. The PRCU session manager shall be capable of providing telemetry data to the PDSS in a format that is compatible with TBD4 specification.

d. The PRCU session manager shall be capable of receiving payload commanding data from the PDSS in a format that is compatible with TBD4 specification.

3.1.2.1.6 PRCU to user facility external interface. The user facility interfaces define the information/resources that will be exchanged between the user facility and the PRCU. The user facility is responsible for providing power, cooling and ventilation resources to support the operation of the PRCU. Figure 10 illustrates the PRCU to user facility external interface.

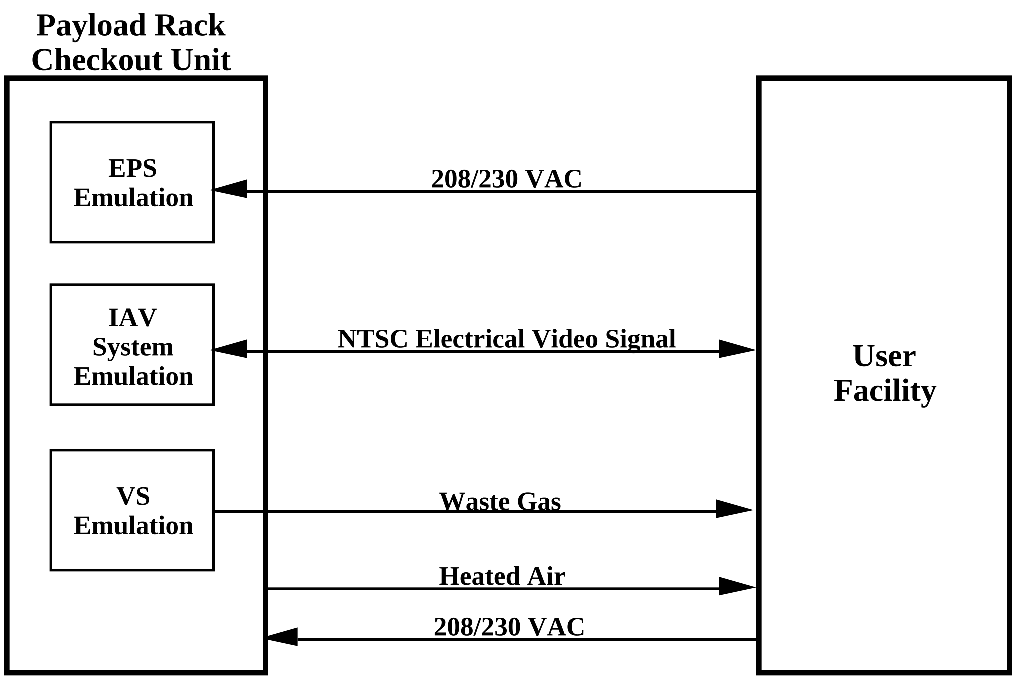

FIGURE 10 PRCU to User Facility External Interface Diagram

a. The PRCU EPS emulation shall accept a 208/230 Volts Alternating Current (VAC), three phase (ABC), Y connection power input that provides a maximum of 18 kW from the user facility.

b. The PRCU EPS emulation shall interface with the 208/230 VAC, three phase (ABC), Y connection facility power via use of commercial cabling and connectors.

c. The PRCU IAV system emulation shall provide NTSC formatted electrical video signals to a user facility provided monitor.

d. The PRCU IAV system emulation shall accept NTSC formatted electrical video signals from a user facility provided video source.

e. The PRCU VS emulation shall exhaust waste gas from the payload rack to the user facility environment.

f. The PRCU shall accept 208/230 VAC, three phase, 6 kW power input(s) from the user facility to operate internal components of PRCU equipment.

g. The PRCU shall interface with 208/230 VAC, three phase (ABC), 6 kW facility power via commercial cabling and connectors.

h. The PRCU shall exhaust heat generated by internal equipment to the ambient user facility environment.

i. The PRCU shall maintain operable internal equipment by utilizing cooling air provided by TBD5 resource.

j. The PRCU electrical equipment shall be properly grounded per the National Electric Code (NEC).

3.1.2.2 Internal interfaces. The internal interfaces define how information and data is exchanged between the major components of the PRCU.

3.1.2.2.1 DAPC - C&DH system emulation internal interface.

a. The Command & Control (C&C) simulation shall provide user defined set point commands to the DAPC for controlling the PRCU provided physical systems.

b. The C&C simulation shall provide payload requested set point commands to the DAPC for controlling the PRCU provided physical systems.

c. The DAPC shall provide ancillary data to the C&C simulation for use by the payload.

3.1.2.2.2 DAPC - EPS emulation internal interface.

a. The DAPC shall manipulate EPS emulation effectors to carry out user defined EPS set points for a given test session.

b. The DAPC shall receive EPS emulation sensor status readings.

3.1.2.2.3 DAPC - Gas servicing emulation internal interface.

a. The DAPC shall manipulate gas servicing emulation effectors to carry out user defined gaseous set points for a given test session.

b. The DAPC shall receive gas servicing emulation sensor status readings.

3.1.2.2.4 DAPC - ITCS emulation internal interface.

a. The DAPC shall manipulate ITCS emulation effectors to carry out user defined low and/or moderate temperature loop set points for a given test session.

b. The DAPC shall receive ITCS emulation sensor status readings.

3.1.2.2.5 DAPC - VS emulation internal interface.

a. The DAPC shall manipulate VS emulation effectors to carry out user defined vacuum resource and exhaust set points for a given test session.

b. The DAPC shall receive VS emulation sensor status readings.

3.1.2.2.6 Off-line tools - session manager internal interface.

The off-line tools shall provide file access to the session manager for use in configuring the test session.

3.1.2.2.7 Session manager - C&DH internal interface.

a. The session manager shall provide test conductor defined payload commands to the C&C simulation.

b. The session manager shall provide ground defined payload commands to the C&C simulation.

c. The session manager shall provide Portable Computer System (PCS) commands to the C&C simulation.

d. The session manager shall provide Timeliner commands to the C&C simulation.

e. The session manager shall provide flight configuration commands for the Automated Payload Switch (APS)/High Rate Frame Multiplexer (HRFM) interface to the C&C simulation.

f. The session manager shall provide test session commands to the core systems simulations.

g. The session manager shall provide test session commands to the C&C simulation.

h. The session manager shall provide test execution commands to the IAV emulator.

i. The session manager shall provide test execution commands to the Remote Terminal (RT) simulation.

j. The session manager shall receive test status from the C&C simulation.

k. The session manager shall receive test status from the IAV emulator.

l. The session manager shall receive test status from the RT simulation.

m. The session manager shall receive test status from the core systems simulation

n. The session manager shall receive payload and Payload Executive Processor (PEP) operational status data from the C&DH emulation to support data logging and data display functions.

3.1.2.2.8 Session manager - DAPC internal interface.

a. The session manager shall issue set point commands to the DAPC which will manipulate the physical resources provided to the payload rack (i.e. EPS, ITCS, Gas Services, and the VS).

b. The session manager shall receive sensor status readings from the emulations to monitor the physical resources provided to the payload rack.

3.1.3 Major component list.

a. C&DH system emulation
b. EPS emulation
c. Gas servicing emulation
d. IAV emulation
e. ITCS emulation
f. VS emulation
g. DAPC
h. Off-Line tools
i. Session Manager

3.1.4 Government furnished property list. Not Applicable (N/A)

3.1.5 Government loaned property list. N/A

3.2 Characteristics.

3.2.1 Performance.

The PRCU shall not degrade or contaminate any attached flight payload system/hardware.

3.2.1.1 Design goals. The following statements are design goals that the PRCU developers plan to incorporate into its design and implementation.

a. The PRCU C&DH system emulation will provide the capability to support ISPR monitoring, data display, and payload commanding.

b. The PRCU will provide a high fidelity emulation of ISPR to Space Station interfaces which include the C&DH system, the IAV and HRDL portions of the C&T system, the ITCS, the EPS, the VS, and the gas servicing system.

c. The PRCU will be transportable to support interface test/verification procedures at a user's development site.

d. The PRCU will support interface test and verification tasks for a single payload mounted in one or multiple racks which are operating at the same time.

e. The PRCU will optimize the use of Commercial Off The Shelf (COTS) hardware and software.

f. In the event of a fault or error, the PRCU will not adversely degrade itself or any flight payload hardware.

g. The PRCU will support the development, qualification, acceptance, interface testing, and operation of flight ISPRs.

h. The PRCU will provide fault monitoring, operation and control at a level that supports minimal operator intervention during normal operations.

i. The PRCU will be capable of monitoring system behavior, detecting system faults, and displaying system health information.

j. The PRCU will support various states and modes within those states which support payload verification tests.

k. The PRCU will be capable of emulating the payload interface time constants, the static ranges, and the delays anticipated on the Space Station to support payload interface test/verification.

l. The PRCU will provide for adequate maintenance and servicing access to PRCU equipment.

m. The PRCU will be designed to permit maintenance with general purpose tools and equipment available commercially.

n. The PRCU electrical equipment will be properly connected to the facility grounding system.

o. The PRCU will provide for self-test and diagnostics to minimize the time required for equipment maintenance, testing, and troubleshooting.

p. The PRCU will be designed in a modular manner to facilitate upgrades and enhancements resulting from advanced technologies.

q. The PRCU design and construction will minimize the impact to existing software and hardware if additional functionality is added at a later date.

r. The PRCU will be supported by PSIVF technical resources to assist ISPR payload developers with problems encountered during PRCU operation.

s. The PRCU will be supported by the PSIVF to fix PRCU units or components returned for repair.

t. The PRCU will be user serviceable to the maximum extent possible.

u. PRCU design will incorporate the intent of MIL-STD-1472.

3.2.1.2 PRCU states The PRCU supports both operational and non-operational states. The PRCU operational states include the Pre-test state, the Test state, and the Post-test state. Figure 11 illustrates the PRCU operational state transition diagram. The PRCU non-operational states include the maintenance state and the calibration state. Subsequent paragraphs define the PRCU states and modes of operation.

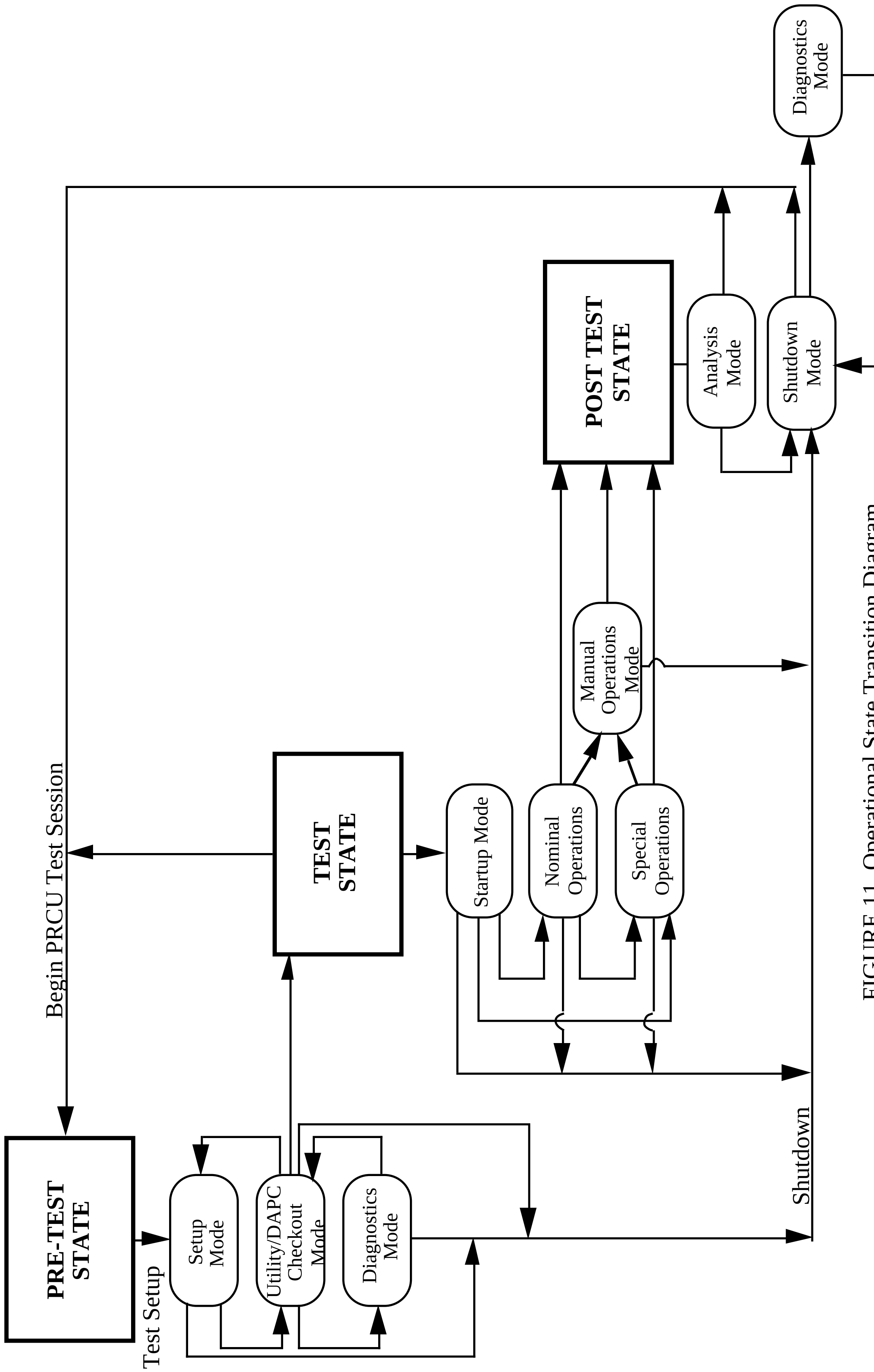

FIGURE 11 Operational State Transition Diagram

3.2.1.2.1 Operational states.

3.2.1.2.1.1 Pre-test state. The PRCU Pre-test state is the state that the PRCU is in prior to beginning an interface verification test. The Pre-test state will allow the user to define the configuration of the PRCU equipment as well as the parameters that will be tested during the PRCU Test State. The Pre-test state has the following modes of operation: the setup mode, the utility/instrument/DAPC checkout mode, and the diagnostics mode.

3.2.1.2.1.1.1 Setup mode. In the setup mode, the user defines PRCU configurations and Payload configurations to support the test and verification of the payload to Station Interfaces. Defining PRCU configurations consists of selecting PRCU hardware and software for a particular test case. This would consist of downloading pertinent files and/or scripts from the PSIVF and/or the PDL, defining/modifying PRCU equipment configurations, and manually connecting the appropriate PRCU hardware to the payload under test. Defining payload configurations consists of selecting the payload hardware and software for a particular test case as well as declaring the number of payload racks that will be operational (1 to 3 racks available). This would include defining/modifying payload commands, developing/modifying user screens, and defining/modifying test scripts. Test scripts are defined as a series of payload and/or PRCU commands that will test specific interfaces. The user can use these test scripts to establish test session configurations that will execute specific test scripts and thus verify a variety of payload to station interfaces.

Once the PRCU and the Payload commands and scripts have been defined, the hardware and software has to be initialized and made ready for the interface verification test. PRCU Initialization activities include: the manual powerup of PRCU equipment and the running of equipment Built In Tests (BITs) and/or the Power On Self Tests (POSTs), the selection and loading of user defined scripts, and the specification of data logging parameters. The initialization of the payload hardware and software is also conducted at this time.

3.2.1.2.1.1.2 Utility/instrument/DAPC checkout mode. In the checkout mode, an extensive suite of tests will be performed on both the PRCU equipment and the payload equipment mounted in the ISPR(s). The PRCU system emulations, the PRCU instrumentation, and the Data Acquisition and Process Controller will under go a series of calibration tests to ensure proper operation during the Test State.

3.2.1.2.1.1.3 Diagnostics mode. The diagnostics mode is available to assist the user with anomaly resolution of problems that may have occurred during configuration activities. Typical procedures that may be conducted in the diagnostics mode would be manually troubleshooting the PRCU and/or Payload equipment that failed the BIT or POST.

3.2.1.2.1.2 Test State The PRCU Test state is the state that the PRCU is in when an ISPR interface verification test is in progress. The Test state allows the user to test their payload interface with any and all of the ISPR interfaces that are available on Station. During the test, the PRCU will achieve the proper values of U.S. payload interface parameters necessary for test/verification. This includes the static ranges as well as the dynamic ranges of the ISS Lab, the JEM, and the APM. The PRCU Test state has four modes of operation: the startup mode, the nominal operations mode, the special operations mode, and the manual operations mode.

3.2.1.2.1.2.1 Startup mode. In the startup mode, the user selects the configuration that is to be used during the test session. The user interface will supply a menu listing of the information that was defined/modified during the initialization mode (i.e. payload commands, PRCU commands, script selection, logging parameters, display parameters, etc.)

3.2.1.2.1.2.2 Nominal operations mode In the nominal operations mode, the PRCU is conducting the test according to the selected scripts.

3.2.1.2.1.2.3 Special operations mode In the special operations mode, the PRCU will conduct a test for a special interface or condition that needs to be verified.

3.2.1.2.1.2.4 Manual operations mode In the manual operations mode, the PRCU can be used to resolve problems that may have occurred in either nominal operations mode or the special operations mode. In the manual operations mode, the automatic control of PRCU equipment is taken off-line and the test conductor can set signal values that will be directly received by the actuator. This type of manual operations control will allow the test conductor to pinpoint equipment and/or software that is not performing correctly.

3.2.1.2.1.3 Post-test state. The PRCU Post-test state is the state that the PRCU is in after an interface verification test has been completed. In the Post-test state, logged data from the interface verification test can be reviewed for analysis. The PRCU and the payload equipment is also shut down and made ready for the next PRCU test. The Post-test state has three modes of operation: the analysis mode, the shutdown mode, and the diagnostics mode.

3.2.1.2.1.3.1 Analysis mode. In the analysis mode, the data that was logged during the interface verification test can be retrieved and reviewed. This capability will allow the user to verify that the results of the test are within the station limits for the ISS Lab systems.

3.2.1.2.1.3.2 Shutdown mode. In the shutdown mode, the PRCU test session is terminated in an orderly manner. The logged data for the test session is collected and filed, the payload equipment in the ISPR under test will be powered down, and the PRCU system emulation equipment will be returned to the powered off mode.

3.2.1.2.1.3.3 Diagnostics mode. In the diagnostics mode, the PRCU can be used to support anomaly resolution of problems that may have occurred during the shutdown process.

3.2.1.2.2 Non-operational states.

3.2.1.2.2.1 Maintenance state. In the maintenance state, the PRCU equipment will be serviced and/or repaired in preparation for future test sessions. The PRCU Maintenance Plan, D683-27522-1, will provide the details for PRCU maintenance.

3.2.1.2.2.2 Calibration state. In the calibration state, the PRCU equipment will be calibrated to certain tolerances to ensure proper ISS to payload interface verification. The PRCU Metrology Plan, D683-21439-1, will provide the details for the calibration of PRCU equipment.

3.2.2 Physical characteristics.

3.2.2.1 Weight.

This section will remain TBD6 until completion of the Facilitization trade study.

3.2.2.2 Dimensions.

This section will remain TBD6 until completion of the Facilitization trade study.

3.2.2.3 Mobility.

This section will remain TBD6 until completion of the Facilitization trade study.

3.2.2.4 Durability

This section will remain TBD6 until completion of the Facilitization trade study.

3.2.3 Reliability. Not Applicable.

3.2.4 Maintainability.

3.2.4.1 Accessibility.

a. PRCU design shall permit ready access to interior parts for easy removal and replacement of major component parts without the use of special tools.

b. The PRCU shall provide interfaces for external calibration equipment to facilitate in-place calibration of both electrical and mechanical subsystems or components.

3.2.4.2 Component installation, removal, and repair.

PRCU components subject to normal or routine replacement or servicing shall not be secured by rivets, welding, or other means that would prohibit removal and replacement.

3.2.4.2.1 Fasteners.

The PRCU shall include captive fasteners on those components which normally require removal for maintenance and troubleshooting.

3.2.4.2.2 Tools and test equipment.

The PRCU shall be designed to permit maintenance with general purpose tools and equipment available commercially.

3.2.4.3 Calibration.

The calibration of the PRCU shall be defined in the PRCU Metrology Plan (D683-21439-1).

3.2.5 Environmental conditions.

This section will remain TBD7 until completion of the Facilitization trade study.

3.2.6 Transportability.

This section will remain TBD8 until completion of the Facilitization trade study.

3.2.7 Expansion. Not Applicable.

3.3 Design and construction.

3.3.1 Structures, materials, process and parts.

a. PRCU equipment shall be new and of recent manufacture when initially purchased.

b. PRCU COTS electrical or electronic items shall be Underwriters Laboratory (UL) approved.

3.3.2 Electromagnetic radiation.

This section will remain TBD9 until Critical Design Review (CDR).

3.3.3 Nameplates and product marking.

a. PRCU equipment shall be marked for information and identification per MIL-STD-130.

b. The PRCU markings shall remain legible for the service life of the equipment to which they are affixed.

c. PRCU gaseous lines and tubing shall be marked with standard decals to indicate direction of flow and content.

d. PRCU wire bundles, fiber optic cables, and gaseous lines shall be functionally identifiable at each end and at 5 meter intervals along the lines.

e. Hoist and lift points shall be provided and clearly labeled for PRCU items requiring mechanical or power lift for movement.

3.3.4 Workmanship.

a. PRCU components, including finished equipment shall be free from defects which affect their serviceability or appearance.

b. Manufacturing drawings shall specify workmanship levels.

c. Workmanship inspections shall be performed in accordance with NHB-5300.4(1B).

3.3.5 Interchangeability.

a. All assemblies and units that have the same part number shall be functionally and dimensionally interchangeable.

b. PRCU software of an identical nature shall be interchangeable between the PRCU, the PSIVF, and the Suitcase Test Environment for Payloads (STEP).

c. PRCU hardware of an identical nature shall be interchangeable between the PRCU and the STEP.

3.3.6 Safety.

a. The PRCU shall be designed such that failure of PRCU components will not present a hazard to operating personnel or flight hardware.

b. PRCU equipment shall be designed in accordance with CFR 1910 as a minimum.

c. Caution and warning notices shall be prominently displayed on PRCU equipment where the risk of injury to operating or maintenance personnel exists.

d. Electrical Direct Current (DC) systems shall be grounded according to NEC article 250-3 and 250-22.

e. Electrical Alternating Current (AC) circuits and systems shall be grounded according to the NEC articles: 250-5b, 250-23, and 250-25

f. Fully loaded PRCU equipment racks shall not tip over during normal handling procedures.

g. Access to energized cabinets for maintenance purposes shall be per the NEC.

3.3.6.1 Pressurized system components.

a. PRCU pressurized components shall meet the requirements of American Society of Mechanical Engineers (ASME)/American National Standards Institute (ANSI) B31.1.

b. PRCU pressurized components shall be two fault tolerant to prevent over pressurization of flight equivalent hardware.

c. PRCU pressurized lines and tubing shall be restrained.

3.3.7 Human performance/human engineering.

a. ISS accepted terminology, acronyms, and abbreviations shall be used throughout PRCU documentation and code.

b. PRCU displays shall be configured to allow similar applications to utilize the same operator procedures.

3.3.7.1 Accessibility.

a. Accesses and covers shall be devoid of sharp corners and be equipped with grasp areas.

b. Sliding, rotating, or hinged units shall be free to open or rotate their full distance and remain in the open position without being supported by hand.

c. Any access door, lid, or cover, behind which a potentially hazardous condition may exist shall be labeled with appropriate warning.

d. Accessible, normally exposed surfaces of PRCU equipment shall have a touch temperature between 40 degrees F and 113 degrees F.

3.3.7.2 Installation/Removal.

TBD10

3.3.8 Security.

The PRCU shall be in compliance with the rules set forth by NASA Automated Information Security (AIS) System level 2 security excluding encryption defined in NHB 2410.9

3.4 Documentation.

a. PRCU documentation shall provide traceability to the capabilities defined in the Pressurized Payloads Interface Definition Document, SSP 52000.

b. PRCU documentation shall be written in the English language.

c. PRCU documentation shall cover the hardware, the software, the drawings, and the procedures necessary to install, maintain, operate, and repair PRCU equipment. This includes COTS items and any associated modifications to those items.

d. A hard copy of the PRCU User’s Guide, D683-21441-1, shall be delivered with the PRCU.

e. PRCU drawing requirements will be described in the PSIV/F Development Plan, D683-41212-1.

3.5 Logistics.

3.5.1 Maintenance.

PRCU equipment shall be capable of being maintained and repaired via removal/replacement of hardware components.

3.5.2 Supply.

The PRCU shall provide for the provisioning of consumable items.

3.5.3 Facilities and facility equipment. This section will remain TBD11 until the facilitization trade study is complete. At that time high level requirements will be placed in this section and more detailed facility requirements will be included in lower level PRCU documentation (Facility Design Criteria Document and/or PRCU Users Guide).

3.5.3.1 Power

TBD11

3.5.3.2 Heating, Ventilation, and Cooling (HVAC).

TBD11

3.5.3.3 Lighting.

TBD11

3.5.3.4 Fire Detection and Suppression.

TBD11

3.5.3.5 Flooring.

TBD11

3.6 Personnel and training.

3.6.1 Personnel.

TBD12

3.6.2 Training.

TBD12

3.7 Major component characteristics.

3.7.1 C&DH system emulation. The C&DH system emulation will allow payload developers to test and verify their payload's interface to the ISS C&DH system. Payloads requiring services (i.e. Timeliner procedure execution, file request services, ancillary data services, and/or low rate telemetry services) provided by the Payload Executive Software (PES), payloads required to provide health and status data, or payloads required to provide safety data to the Payload MDM must ensure that their messages comply with MIL-STD-1553B protocol as well as generate the correct data structures and content. The C&DH system emulation will also be used to verify the payloads' interface with the Payload Ethernet Hub Gateway (PEHG), the APS, and the HRFM. Figure 12 provides an overview of the C&DH Emulation Architecture.

3.7.1.1 General.

a. The PRCU C&DH system emulation shall monitor low, medium, and high rate payload data for compliance with the CCSDS packet format specified by the ISS program.

b. The C&DH system emulation shall review the CCSDS header for a valid Application Process Identifier (APID).

c. The C&DH system emulation shall provide MIL-STD-1553B connections to accommodate a PCS FEU.

d. The C&DH system emulation shall allow the execution of payload MDM flight software.

e. The C&DH system emulation shall allow the execution of PCS flight software and displays for station provided PCS devices.

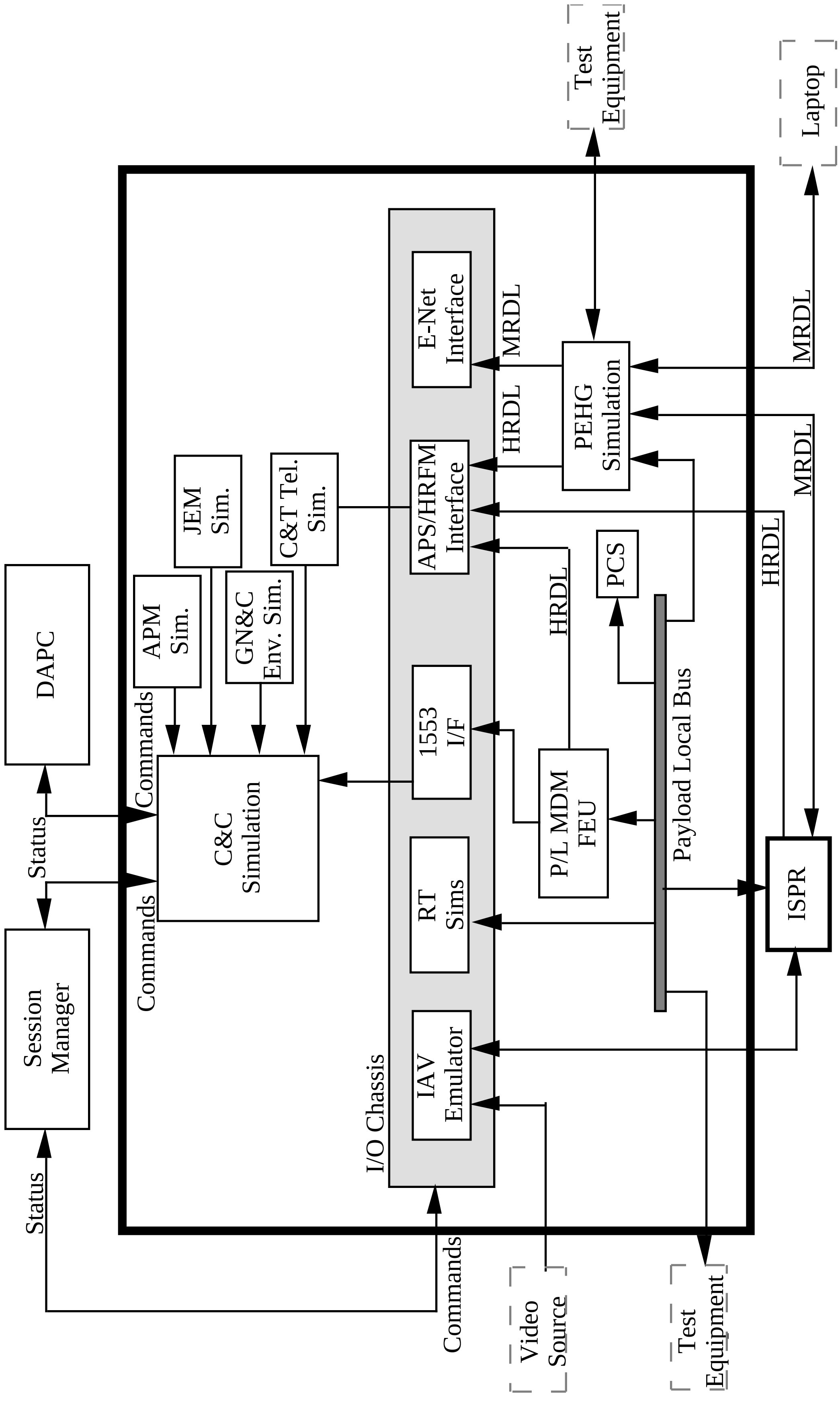

FIGURE 12 C&DH Emulation Architecture

3.7.1.2 C&C MDM simulation.

The C&C MDM simulation shall meet the flight software interface requirements of the Payload MDM as defined in SSP 41175-8, Software ICD, Part 1, Station Management & Control to ISS, Book 8, Payload MDM Interface.

3.7.1.3 PEHG simulation.

a. The PRCU PEHG simulation shall support a user provided crew laptop, a user provided station PCS, and the transfer of payload command/telemetry data.

b. The PRCU PEHG simulation shall operate at the data rate of consistent with the implementation of a 10BASE-T network.

c. The PRCU PEHG simulation shall provide performance functionality per the requirements of SP-M-502, section 3.2.1.1. except as follows:

(1) the simulation will use the number of ports specified in section 3.1.2.1.2 b of this specification,

(2) an Attachment User Interface (AUI) port is not required,

(3) the functions utilizing the MIL-STD-1553B interface will be accomplished via the PRCU command capability,

(4) the requirements pertaining to a single extended network do not apply,

(5) the packet statistics requirements are provided in requirement i of this section.

d. The PRCU PEHG interface simulation shall be capable of capturing 10Base-T packets including packets normally routed for downlink via the PEHG gateway function.

e. The PRCU PEHG interface simulation shall simulate the gateway buffering capabilities consistent with the requirements of SP-M-502, section 3.2.1.2.1, except as follows:

(1) the gateway functions IEEE 802.3 address is not required to be programmable,

(2) the removal of the IEEE 802.3 packet overhead, the capability of latching into the TAXI encoding chip, and the gateway's output data rate are not applicable.

f. The PRCU PEHG interface simulation shall simulate gateway buffer full conditions consistent with SP-M-502, section 3.2.1.2.1, except as follows:

(1) all packets will be logged,

(2) functions utilizing the MIL-STD-1553B interface will be accomplished via the PRCU command capability.

g. The PRCU PEHG interface simulation shall simulate flow control capabilities consistent with SP-M-502, section 3.2.1.2.1, except as follows:

the functions utilizing the MIL-STD-1553B interface will be accomplished via the PRCU command capability.

h. The PRCU PEHG interface simulation shall be controlled via simulation control functions consistent with the requirements in SP-M-502, section 3.2.1.3.2.2, except as follows:

(1) command functions utilizing the MIL-STD-1553B interface will be accomplished via the PRCU command capabilities,

(2) the response time from receipt of a command is not applicable,

(3) loading of the gateway IEEE 802.3 address and output data rate are not applicable.

i. The PRCU PEHG interface simulation shall provide reporting functions consistent with the requirements of SP-M-502, section 3.2.1.3.2.3, except as follows:

(1) command functions utilizing the MIL-STD-1553B interface will be accomplished via the PRCU command capabilities,

(2) the response time from receipt of a command is not applicable.

3.7.1.4 APS/HRFM simulation.

a. The PRCU APS/HRFM simulation shall be capable of determining and reporting the data rate of the payload generated HRDL packet or HRDL bitstream.

b. The PRCU APS/HRFM simulation shall be capable of determining and reporting the packet gap between payload generated HRDL packets.

c. The PRCU APS/HRFM simulation shall be capable of capturing all payload generated HRDL packet data up to a sustained data rate of 43.2 Mb/s.

d. The PRCU APS/HRFM simulation shall be capable of capturing all payload generated HRDL bitstream data up to a sustained data rate of 43.2 Mb/s.

e. The PRCU APS/HRFM simulation shall be capable of determining and reporting payload generated HRDL packet delimiter values.

f. The PRCU APS/HRFM simulation shall be capable of determining and reporting data transmission errors on the HRDL interface.

g. The PRCU APS/HRFM simulation shall be capable of determining and reporting HRDL packet and byte count statistics.

h. The PRCU APS/HRFM simulation shall allow PRCU commands to start and stop the capture of payload generated HRDL data.

i. The PRCU APS/HRFM simulation shall allow PRCU commands to initialize the HRDL interface.

j. The PRCU APS/HRFM simulation shall allow PRCU commands to reset the HRDL interface.

k. The PRCU APS/HRFM simulation shall allow PRCU commands to control the transfer of captured HRDL data from the HRDL interface for logging.

l. The PRCU APS/HRFM simulation shall allow PRCU commands to control the transfer of HRDL interface status data for display.

m. The PRCU APS/HRFM simulation shall group captured HRDL data and related statistics for logging.

n. The PRCU APS/HRFM simulation shall transfer the grouped data (captured data and statistics data) to the PRCU logging function for logging.

3.7.1.5 Low level protocol testing.

a. The PRCU low level protocol testing function shall have the capability to verify that the payload interface has properly implemented all the MIL-STD-1553B required (non-optional) parameters.

b. The PRCU low level protocol testing function shall have the capability to verify that the payload interface responds properly to a series of off-nominal/error conditions for parity, bit count, Manchester encoding, sync character, data continuity, word count, and intermessage gap in the MIL-STD-1553B interface.

c. The PRCU low level protocol testing function shall have the capability to report all anomalies generated during the test including: RT error, status response, and bus activity statistics and time correlation of activities.

d. The PRCU low level protocol testing function shall verify that a payload meets MIL-STD-1553B protocol specifications.

3.7.1.6 RT simulation data.

a. The PRCU shall provide a configurable RT simulation to allow simulated payload local bus RT data to be included in payload specific ancillary data.

b. The PRCU shall provide a configurable RT simulation(s) to allow simulated payload local bus RT data to be included in PCS display data.

3.7.1.7 APM simulation.

The PRCU APM simulation shall provide a configurable set of data to the C&C MDM simulation to be included in the APM Lateral Transfer message sent to the Payload MDM FEU.

3.7.1.8 JEM simulation.

The PRCU JEM simulation shall provide a configurable set of data to the C&C MDM simulation to be included in the Payload Specific ancillary data message sent to the Payload MDM FEU.

3.7.1.9 Guidance Navigation & Control (GN&C) simulation.

The PRCU GN&C simulation shall provide a non-configurable set of data to the C&C MDM simulation to be included in the Payload Specific Ancillary Data Message and/or the Broadcast Ancillary Data message sent to the Payload MDM FEU.

3.7.1.10 C&T telemetry simulation

The PRCU C&T telemetry simulation shall provide a non-configurable set of data to the C&C MDM simulation to be included in the payload specific ancillary data message and/or the broadcast ancillary data message sent to the Payload MDM FEU.

3.7.2 EPS emulation. The PRCU EPS emulation will be capable of distributing station compatible power from a single power input to multiple power outputs. The EPS emulation will operate within the voltage range of 0 to 180 Volts Direct Current (VDC), and with a current range of 0 to 120 Amps Direct Current (ADC). The EPS emulation will be capable of switching loads that meet or exceed Station requirements. Each EPS emulation power outlet feed will be independently controlled and remotely or locally commandable to an "on" or "off" power state. The EPS emulation will also be capable of automatically switching an output to an "off" power state when the load exceeds a predetermined current limit. The voltage and current supplied by the power test portion of the EPS emulation will provide the same operating voltage and current characteristics of the Station Remote Power Control Module (RPCM). A digital display will present the output voltage and current status of the EPS emulation. Additionally, measurement points at the power output will be available for monitoring by external test equipment. The PRCU EPS emulation will have the ability to output a total of at least 14 kW total power (continuous).

From the PRCU EPS emulation, input power to the ISPR will appear as two independent Direct Current (DC), isolated ISS power buses. The PRCU EPS emulation will use ISS compatible connectors for both the 3 kW and 6 kW main power (J1) interface and the essential/auxiliary power (J2) interface.

Test capabilities will emulate the nominal soft start/stop characteristics of ISS system RPCMs that control power to ISPR locations. The unit will support rack inrush/initialization current testing. The unit will be capable of simulating ISS EPS abnormal power characteristics, including the capability to provide variable voltage and current levels, the capability to rapidly deenergize and reenergize the rack interface, and the capability to simulate the complete elimination of power to the ISPR from the power source.

Independently controllable power feeds will have individual circuit protection and utilize connectors that are terminated in sockets (rather than pins) for user safety. EPS emulation hardware to rack electrical grounding will incorporate the use of ground straps and/or ground wires to achieve a safe operating environment.

a. The PRCU EPS emulation shall provide a maximum of 13 kW total DC power to all three ISPR locations.

b. The PRCU EPS emulation shall provide a maximum of 12 kW total DC power to any one ISPR location.

c. The PRCU EPS emulation shall provide selectable steady state voltage limits within the range 116 to 126 VDC (inclusive) at Interface B.

d. The steady state voltage limits for Interface B shall be selectable in TBD13 VDC increments

e. The PRCU EPS emulation shall provide selectable steady state voltage limits within the range 113 to 126 VDC (inclusive) at Interface C.

f. The steady state voltage limits for Interface C shall be selectable in TBD14 VDC increments.

g. The PRCU EPS emulation shall provide a maximum ripple voltage of 3.0 Volts peak-to-peak with spectral components as shown in Figure 3.2-2 of SSP-52000, the Pressurized Payload IDD.

h. The PRCU EPS emulation shall provide the transient voltage ranges and maximum transient recovery times for Interface B and C shown in Figures 3.2-3 and 3.2-4 of SSP-52000.

i. The PRCU EPS emulation shall provide the source impedance for Interface B and C shown in Figures 3.2-5, 3.2-6, and 3.2-7 of SSP-52000.

j. The PRCU EPS emulation shall provide surge current at the main power and the Auxiliary/Essential input power locations that is within the surge current values defined in Figures 3.2-11 and 3.2-12 of SSP-52000.

k. The PRCU EPS emulation shall provide reverse energy/current values compatible with Table 3.2-I of SSP-52000.

l. The PRCU EPS emulation shall not allow a payload to use Essential/ Auxiliary power while the main power is within the steady-state, transient, or abnormal voltage limits specified above in paragraphs c & e.

m. The PRCU EPS emulation shall provide electrical grounding through the pin/contact at insert B of the Main and Essential/Auxiliary power connectors on the Active Rack Isolation System (ARIS) UIP.

n. The PRCU EPS emulation shall provide the capability to simulate the line losses from the RPCM to the payloads' on-orbit ISPR location.

o. The PRCU EPS emulation shall distribute and protect at least 3 kilowatts (kW) of 120 VDC power to the payload rack.

p. PRCU EPS emulation components which do not interface with flight hardware shall comply with NFPA-70, the NEC.

q. The PRCU EPS emulation shall support isolation of the power bus high side and return lines.

r. The PRCU EPS emulation shall provide soft start/stop RPCM characteristics to the payload rack.

3.7.3 Gas servicing emulation. The PRCU will provide a gas servicing unit to distribute Nitrogen, Argon, Helium, and/or Carbon Dioxide service at the constant rate and pressure that meets ISS testing requirements. The gas servicing unit provides the user with the capability to vary the gas supply pressure while monitoring the pressure rate. The PRCU supply pressure and rates will meet the values required for payload verification testing. The gas servicing unit will also meet ISS cleanliness and material standards.

3.7.3.1 General.

a. The PRCU gas servicing emulation shall provide the capability to vary the supply pressure of a gas to the payload rack.

b. The PRCU gas servicing emulation shall provide the capability to monitor the flow rate and pressure of the gas provided to the payload rack.

3.7.3.2 Nitrogen distribution.

a. The PRCU gas servicing emulation shall provide nitrogen at an interface pressure range between 75 and 120 psia.

b. The PRCU gas servicing emulation shall provide nitrogen at an interface temperature range between 60 F and 113 F.

c. The PRCU gas servicing emulation shall provide nitrogen at a maximum flow rate of 12 pounds mass per hour (lbm/hr).

d. The PRCU gas servicing emulation shall provide a maximum design pressure for nitrogen distribution of 200 psia.

e. The PRCU gas servicing emulation shall verify that the maximum flow rate for nitrogen distribution does not exceed 12 lbm/hour.

3.7.3.3 Argon distribution.

a. The PRCU gas servicing emulation shall provide argon at an interface pressure range between 75 and 114 psia (517 to 768 Kilopascal (kPa)).

b. The PRCU gas servicing emulation shall provide argon at a maximum flow rate of 20 Normal liters/ minute.

c. The PRCU gas servicing emulation shall provide a maximum design pressure for argon distribution of 200 psia (1379 kPa).

d. The PRCU gas servicing emulation shall verify that the maximum flow rate for argon distribution does not exceed 20 Normal litres/minute.

3.7.3.4 Carbon dioxide distribution

a.. The PRCU gas servicing emulation shall provide carbon dioxide at an interface pressure range between 75 and 114 psia (517 to 768 kPa).

b. The PRCU gas servicing emulation shall provide carbon dioxide at a maximum flow rate of 5 Normal liters/minute.

c. The PRCU gas servicing emulation shall provide a maximum design pressure for carbon dioxide distribution of 200 psia (1379 kPa).

d. The PRCU gas servicing emulation shall verify that the maximum flow rate for carbon dioxide distribution does not exceed 5 Normal litres/minute.

3.7.3.5 Helium distribution.

a. The PRCU gas servicing emulation shall provide helium at an interface pressure range between 75 and 114 psia (517 to 768 kPa).

b. The PRCU gas servicing emulation shall provide helium at a maximum flow rate of 20 Normal liters/minute.

c. The PRCU gas servicing emulation shall provide a maximum design pressure for helium distribution of 200 psia (1379 kPa).

d. The PRCU gas servicing emulation shall verify that the maximum flow rate for helium distribution does not exceed 20 Normal litres/minute.

3.7.4 IAV system emulation.

The PRCU IAV system emulation shall perform the required conversion to/from optimum PFM from/to NTSC baseband signals.

3.7.5 ITCS emulation. The PRCU ITCS emulation will provide low and moderate temperature cooling service to a payload. Water-charged payloads will be supplied by a variable pressure mechanism whose maximum pressure and flow rate will meet ISS requirements for both the moderate and low temperature loops. Coolant supply temperatures for both moderate and low temperature loops will be provided to payloads via a selectable temperature range that meets ISS requirements. Inlet water temperature is established by the ISS program. The outlet water temperature is selectable by adjusting the pressure and the flowrate of the cooling fluid. Both the low and the moderate temperature cooling loops are capable of operating simultaneously and independently. The PRCU ITCS emulation will also provide services that are consistent with the APM and JEM ITCS capabilities to support the verification of U.S. payloads manifested in the APM and the JEM.

3.7.5.1 General.

a. The PRCU ITCS emulation shall emulate the flight ITCS system to the level that flight ITCS dynamic coupling with payload control loops can be monitored.

b. The PRCU ITCS emulation shall be capable of supplying low and moderate temperature water simultaneously and independently to the payload under test.

c. The PRCU ITCS emulation shall provide heat rejection for the low and moderate temperature cooling loops for a combined minimum of 13 kW thermal.

d. The PRCU ITCS emulation coolant supply temperature setpoint shall be non-selectable by the payload.

e. The PRCU ITCS emulation shall provide the capability to monitor the temperature and pressure of the cooling water supplied to and returned from each ISPR under test.

f. The PRCU ITCS emulation shall provide a cooling water servicer to charge water cooled payloads prior to testing.

g. The PRCU ITCS emulation shall provide cooling water that is compatible with the space station contamination levels specified in SSP 30573 (Fluid Procurement and Use Control Specification), Table 4.1-2.8, Note 1.

h. The PRCU ITCS emulation shall provide the capability to drain water from the payload water cooling system.

i. The PRCU shall provide the capability to purge the payload water cooling system after it has been drained.

j. The PRCU ITCS emulation shall allow the payload developer to verify that their payload surface temperatures are above the maximum dew point temperature of 60 F.

k. The PRCU ITCS emulation of the low temperature loop shall provide a maximum pressure differential at the maximum rack flow rate across the supply and return interface lines that does not exceed 5.8 +/- 0.2 psid.

l. The PRCU ITCS emulation of the moderate temperature loop shall provide a maximum pressure differential at the maximum rack flow rate across the supply and return interface lines that does not exceed the pressure drop curve in Figure 3.5-2 of the Payload IDD, SSP 52000.

m. The PRCU ITCS emulation shall provide moderate temperature loop coolant to a payload at a user selectable flow rate within the following ranges:

   0, 100 to 1100 pounds/hour (lb/hr) (45 - 499 kilograms/hour (kg/hr).

n. The PRCU ITCS emulation shall provide low temperature loop coolant to a payload at a user selectable flow rate within the following ranges:

   0, 100 to 512 lb/hr (45 - 232 kg/hr).

o. The PRCU ITCS emulation shall provide moderate temperature loop coolant to a payload at a temperature within the following range:

   61 Fahrenheit (F) to 65 F (16 Celsius (C) - 18.3 C).

p. The PRCU ITCS emulation shall provide low temperature loop coolant at a payload at a temperature within the following range:

33 F to 50 F (.5 C - 10 C).

q. The PRCU ITCS emulation shall monitor the return temperature from the payload to the moderate temperature loop to ensure that it does not exceed the maximum of 120 degrees F.

r. The PRCU ITCS emulation shall monitor the return temperature from the payload to the low temperature loop to ensure that it does not exceed the maximum of 70 degrees F.

s. The PRCU ITCS emulation shall provide a maximum coolant pressure of 100 Pounds per Square Inch Absolute (PSIA) for the moderate temperature loop.

t. The PRCU ITCS emulation shall provide a maximum coolant pressure of 100 PSIA for the low temperature loop.

3.7.5.2 APM unique ITCS emulation.

a. The PRCU ITCS emulation shall provide ITCS coolant to a U.S. payload manifested in the APM at a user selectable flow rate within the following ranges:

0, 66 to 419 lb/hr (30 to 190 kg/hr).

b. The PRCU ITCS emulation shall provide ITCS coolant to a U.S. payload manifested in the APM at a temperature within the following range:

61 F to 68 F (16 C to 20 C)

c. The PRCU ITCS emulation shall monitor the maximum return temperature from a U.S. payload to the ITCS moderate temperature coolant loop to ensure that is does not exceed the maximum of 120 F.

d. The PRCU ITCS emulation shall provide a maximum coolant pressure of 121 psia for the moderate temperature loop interface to an APM payload.

e. The PRCU ITCS emulation shall provide a maximum pressure differential at the maximum rack flow rate across the supply and return interface lines that does not exceed 5.8 +/- 0.2 psid.

3.7.5.3 JEM unique ITCS emulation.

a. The PRCU ITCS emulation shall provide moderate temperature loop coolant to a U.S. payload manifested in the JEM at a user selectable flow rate within the following ranges:

0, 100 to 436 lb/hr (45 to 198 kg/hr).

b. The PRCU ITCS emulation shall provide low temperature loop coolant to a U.S. payload manifested in the JEM at a user selectable flow rate within the following ranges:

0, 100 to 512 lb/hr (45 to 232 kg/hr).

c. The PRCU ITCS emulation shall provide moderate temperature loop coolant to a U.S. payload manifested in the JEM at a non-selectable temperature within the following range:

61 F to 73.4 F (16 C to 23 C)

d. The PRCU ITCS emulation shall provide low temperature loop coolant to a U.S. payload manifested in the JEM at a temperature within the following range:

33 F to 50 F (.5 C - 10 C)

e. The PRCU ITCS emulation shall monitor the return temperature from the payload to the moderate temperature loop to ensure that is does not exceed the maximum of 120 F.

f. The PRCU ITCS emulation shall monitor the return temperature from the payload to the low temperature loop to ensure that it does not exceed the maximum of 70 F.

g. The PRCU ITCS emulation shall provide a maximum coolant pressure of 100 psia for the moderate temperature loop.

h. The PRCU ITCS emulation shall provide a maximum coolant pressure of 100 psia for the low temperature loop.

i. The PRCU ITCS emulation shall provide a maximum pressure differential at the maximum rack flow rate across the supply and return interface lines that does not exceed 5.8 +/- 0.2 psid.

3.7.5.4 <u>CAM unique ITCS emulation</u>.

a. The PRCU ITCS emulation shall provide moderate temperature loop coolant to a U.S. payload manifested in the CAM at a user selectable flow rate within the following ranges:

0, 100 to 1200 lb/hr (45 to 540 Kg/hr).

b. The PRCU ITCS emulation shall provide low temperature loop coolant to a U.S. payload manifested in the CAM at a user selectable flow rate within the following ranges:

0, 100 to 488 lb/hr (45 to 220 Kg/hr).

c. The PRCU ITCS emulation shall provide moderate temperature coolant to a payload manifested in the CAM at a non-selectable temperature within the following ranges:

61 F to 65 F (16 C to 18.3 C).

d. The PRCU ITCS emulation shall provide low temperature coolant to a payload manifested in the CAM at a non-selectable temperature within the following ranges:

38 F to 43 F (3.3 C to 11.3 C).

e. The PRCU ITCS emulation shall monitor the return temperature from the payload to the moderate temperature loop to ensure that is does not exceed the maximum of 120 F.

f. The PRCU ITCS emulation shall monitor the return temperature from the payload to the low temperature loop to ensure that it does not exceed the maximum of 70 F.

g. The PRCU ITCS emulation shall provide a maximum coolant pressure of 100 psia for the moderate temperature loop.

h. The PRCU ITCS emulation shall provide a maximum coolant pressure of 100 psia for the low temperature loop.

i. The PRCU ITCS emulation shall provide a maximum pressure differential at maximum rack flow rate across the supply and return interface lines that does not exceed 5.8 +/- 0.2 psid.

3.7.6 VS emulation

a. The PRCU VS emulation shall be capable of drawing a 250 liter volume to a pressure of $1x10^{-3}$ torr within 45 minutes.

b. The PRCU VS emulation shall provide the capability to monitor the flow rate and pressure of the vacuum resource provided to the payload under test.

c. The PRCU VS emulation shall verify that the payloads maximum interface pressure to the Vacuum Exhaust System does not exceed 40 psia.

d. The PRCU VS emulation shall verify the initial temperature of payload exhaust gases disposed into the vacuum vent system are in the range of 60 to 113 F (16 - 45 C).

e. The PRCU VS emulation shall verify that the initial maximum dew point of payload waste gas disposed into the user facility is 60 F.

3.7.7 DAPC.

a. The DAPC shall provide interfaces to the C&DH emulation, the EPS emulation, the gas servicing emulation, the ITCS emulation, the VS emulation, the session manager, and the payload under test

b. The DAPC shall provide real-time data conversion and transmission.

c. The DAPC shall provide stored values for system operational characteristics of the U.S. Lab, the APM, and the JEM.

d. The DAPC shall provide PRCU control to match ISS static interface characteristics.

e. The DAPC will provide PRCU control to match ISS dynamic interface characteristics.

f. The DAPC shall incorporate and track up to 3rd order linear dynamic reference models of the following major ISS components (at a minimum): Rack Flow

Control Assembly (RFCA), System Flow Control Assembly (SFCA), DC to DC Converter Unit (DDCU), RPCM, and the Central Thermal Bus (CTB).

g. The DAPC shall implement a control system with minimal operator intervention for setup and operation.

h. The DAPC shall provide the capability to tune control parameters without operator intervention.

i. The DAPC shall provide for autonomous operation of the PRCU.

j. The DAPC shall incorporate PRCU health monitoring (fault monitoring).

k. The DAPC shall provide operational states and modes.

l. The DAPC shall accommodate development/test/verification capability for the payload under test.

m. The DAPC shall incorporate test/operational scripts.

n. The DAPC shall provide data management and reporting functionality.

3.7.7.1 Maintenance switch and FDS system signals.

The PRCU shall provide a passive on/off signal interface for the manual removal of power from the payload rack during maintenance.

3.7.8 Off-line tools.

3.7.8.1 General.

a. The PRCU shall provide a tool to support the development of flight-like PCS displays.

b. The PRCU shall provide a tool to support PES command definition.

c. The PRCU shall provide a tool to support Payload MDM table definitions.

d. The PRCU shall provide TBD15 analysis tools.

3.7.8.2 User display development tools.

a. The PRCU shall provide a tool to allow the user to create payload unique graphical displays.

b. The PRCU shall provide a tool to allow the user to integrate payload unique graphical displays with the PRCU provided Graphical User Interface (GUI).

3.7.8.3 Session Preparation tools.

a. The PRCU session preparation tools shall allow the user to define payload unique commands.

b. The PRCU session preparation tools shall allow the user to define payload unique health and status display data definitions.

c. The PRCU session preparation tools shall allow the user to define payload unique low rate telemetry display data definitions.

d. The PRCU session preparation tools shall allow the user to define payload unique ancillary data.

e. The PRCU session preparation tools shall allow the user to define payload unique ancillary data sets.

f. The PRCU session preparation tools shall allow the user to define payload unique MRDL data definitions.

g. The PRCU session preparation tools shall allow the user to define payload unique HRDL packet data definitions.

h. The PRCU session preparation tools shall allow the user to create PRCU command scripts, which may include payload and PRCU commands.

i. The PRCU session preparation tools shall allow the user to define payload MDM configuration tables.

j. The PRCU shall be capable of incorporating flight PES tables into the Payload MDM configuration data.

k. The PRCU session preparation tools shall allow the user to define PEHG interface simulation initialization data.

l. The PRCU session preparation tools shall allow the user to define multiple test session configurations.

m. The PRCU session preparation tools shall allow software configuration changes to accommodate user provided peripherals.

n. The PRCU session preparation tools shall be capable of interfacing with the PDL per the PSIV to PDL ICD (D683-21415-1) (i.e. payload unique commands, ancillary data).

3.7.8.4 User file management tools.

a. The PRCU user file management tools shall provide the capability to backup user files created during the pre-test state.

b. The PRCU user file management tools shall provide the capability to restore user files created during the pre-test state.

c. The PRCU user file management tools shall provide the capability to delete user files created during the pre-test state.

3.7.9 Session manager.

a. The session manager shall be capable of controlling and monitoring the verification system.

b. The session manager shall be capable of displaying color text and graphics.

c. The session manager shall support the development of session configuration and initialization files.

d. The session manager shall provide the capability for the user to select a predefined session configuration for execution.

e. The session manager shall provide the test conductor the capability to interactively insert simulated ground commands during a test session.

3.7.9.1 PRCU Commanding.

a. The PRCU commanding function shall be capable of executing logging commands.

b. The PRCU commanding function shall be capable of executing data display commands.

c. The PRCU commanding function shall be capable of executing simulation control commands.

d. The PRCU commanding function shall be capable of executing user defined command scripts that may contain any combination of user defined payload commands and predefined PRCU commands.

3.7.9.2 Payload Commanding.

The PRCU payload commanding function shall be capable of processing and transmitting user defined payload commands via the Low Rate Data Link (LRDL) interface.

3.7.9.3 Data displays.

3.7.9.3.1 PRCU provided data display services.

a. The PRCU shall be capable of displaying every LRDL message type (i.e. health & status data, low rate telemetry, ancillary data, and MIL-STD-1553B data monitor messages).

b. The PRCU shall be capable of displaying LRDL data in raw and converted format (the converted format is uniquely tailored by the user for their specific payload in the Setup mode).

c. The PRCU shall be capable of displaying every MRDL message type (i.e. telemetry and payload to payload messages).

d. The PRCU shall be capable of displaying MRDL data in raw and converted format (the converted format is uniquely tailored by the user for their specific payload in the Setup mode).

e. The PRCU shall be capable of displaying every HRDL message type (i.e. packet or bitstream).

f. The PRCU shall be capable of displaying a limited pre-selected range of HRDL data in raw and converted format (the limited range is uniquely tailored by the user for their specific payload in the Setup mode).

g. The PRCU shall be capable of displaying PRCU command feedback.

h. The PRCU shall be capable of displaying PRCU status.

3.7.9.3.2 <u>User provided payload data display services.</u>

The PRCU shall be capable of executing payload unique graphical displays created by the user in the Setup mode.

3.7.9.4 <u>Data Logging.</u>

a. The PRCU shall be capable of logging the UOF telemetry feed at 43.2 Megabits per second (Mbits/sec) sustained rate for three minutes.

b. The PRCU shall be capable of logging Command & Control (MIL-STD-1553B) Traffic.

c. The PRCU shall provide the capability to log script-initiated commands.

d. The PRCU shall provide the capability to log test conductor inputs and outputs.

e. The PRCU shall provide the capability to log C&DH bus data.

f. The PRCU shall provide the capability to log control/configuration data.

g. The PRCU shall time-tag data as it is being collected.

h. The PRCU shall provide data logging status to the test conductor.

i. The PRCU shall provide the capability to replay log files.

3.10 <u>Precedence.</u> In the event of conflict of requirements between this document and other related program documents, the following order of precedence shall apply:

a. Purchase contract
b. Statement of work
c. This specification S683-27515
d. Documents referenced in this specification and their references.

4. VERIFICATION

4.1 General. Verification of the PRCU shall be performed as specified in the following sections. The PRCU basic verification approach will be to perform testing at the component level and analysis at the system level.

4.1.1 Responsibility for tests. The PRCU developer will be responsible for performing PRCU testing for acceptance by the customer.

4.1.2 Special tests and examinations. The PRCU developer may conduct development type tests to develop design approaches, select materials or select processes. The PRCU developer is responsible for planning, conducting, and provisioning the development tests. Other special tests and examinations will be performed to determine cause when failures of the following type occur:

Repeated failures occur
Corrective actions are ineffective.
Death or injury occur with no clear cut cause.

4.2 Quality conformance inspection. Appendix A of this specification provides a requirements traceability and verification matrix. This matrix traces PRCU capability requirements to the United States Ground Segment Specification and other relevant Space Station documentation. This matrix also defines how each PRCU requirement will be verified: inspection, demonstration, analysis, or test.

4.2.1 Analysis (A). The process of relating data (by interpolation, extrapolation or interpretation) to the contract specifications of the item or system under consideration. The data reviewed may be derived from documented sources such as design manuals, specifications produced by current or previous testing (conducted in-house, by government agencies or commercial sources), operations or commercial usage or combinations thereof.

4.2.2 Inspection (I). The examination of material (equipment or documentation) to determine quality, quantity or compliance to standards. The inspection of equipment entails the use of methods appropriate to the purpose. For example, comparing an article with the specifications, drawings, examining workmanship visually, employing tools or gages or using fluorescent penetrate.

4.2.3 Demonstration (D). A verification method carried out by the execution of the system with the inputs provided by a predetermined scenario, actual hardware, or test conductor input. Requirements are verified by observing results during the controlled application of functional and environmental stimuli. Results are denoted by the qualitative determination of properties of an end item or component without the use of special test equipment or instrumentation to verify functional performance, human engineering features, transportation, and display data.

4.2.4 Test (T). A procedure or action by which a device, piece of material, piece of machinery or system is subjected to conditions, real or simulated, that will determine or demonstrate its qualities, capabilities or its suitability for use in a particular kind of operation. A test requires controlled conditions and instrumentation to obtain quantitative as well as qualitative data for analysis as appropriate. Accomplishment of objectives may require repetitive testing.

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5. PREPARATION FOR DELIVERY

This section will remain TBD16 until completion of the Facilitization Trade Study

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6. NOTES

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